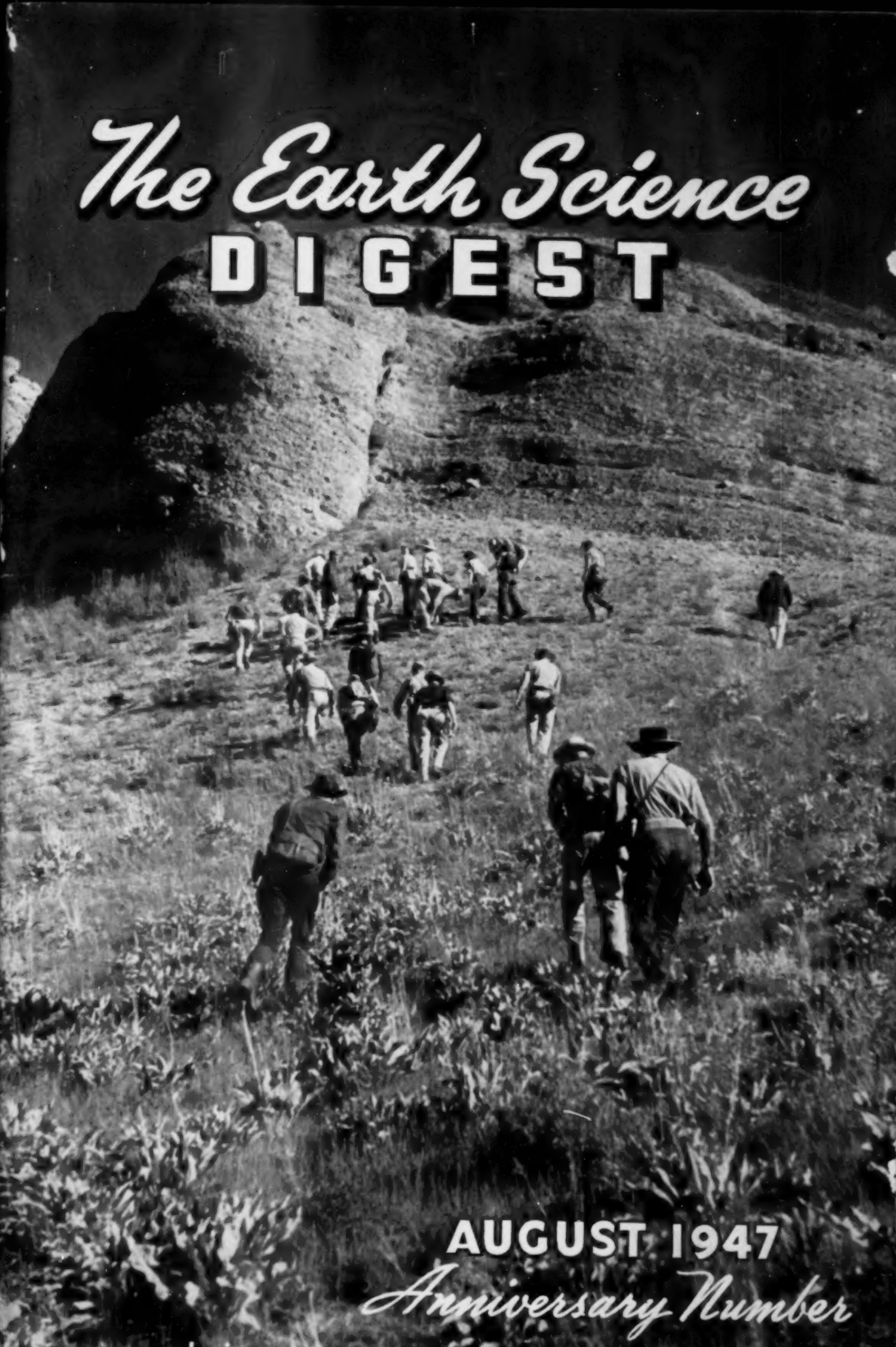
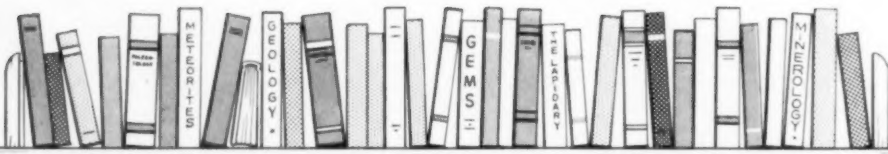
The Earth Science DIGEST



AUGUST 1947

Anniversary Number



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The Earth Science
DIGEST

BOX 57 OMAHA 3, NEBR.

The Earth Science Digest

Box 57 Omaha 3, Nebraska

Published monthly by
THE EARTH SCIENCE PUBLISHING CO.

Hendrik P. Zuidema .... Editor and Publisher
Robert B. Berry .... Associate Editor
J. Charles Gillette .... Advertising Manager
Alice L. Hart .... Circulation and Business Manager

A magazine devoted to the advancement of the geological sciences.

SUBSCRIPTIONS

Per copy	$ .25
1 year	2.00
2 years	3.75
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Vol. II August - 1947 No. 1

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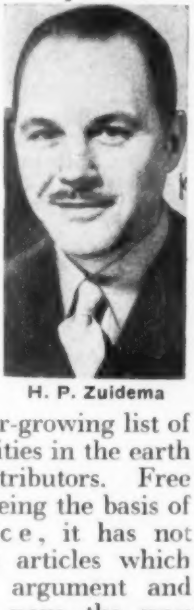
EDITORIAL

With this issue, the first anniversary number of *The Earth Science Digest*, the editorship passes into new and able hands. The press of other matters which demand personal attention caused me to transfer ownership of the magazine to Hendrik P. Zuidema.

The Digest was an experiment, an experiment in service — service to the men and women who desire a fresh approach to the appreciation of Nature; to the young student who seeks advice on where to begin a study of earth sciences, and how to proceed; to the individual collector, seeking to enhance his store of wondrous products from the depths of the Earth; to the scientific institution, seeking to keep informed on the activities of the intelligent amateur as well as those of the professional worker.


H. P. Zuidema

Now, after a year, *The Digest* stands unique. It fills an urgent need in the field of science writing, as evidenced by the ever-growing list of subscribers. Authorities in the earth sciences are its contributors. Free expression of ideas being the basis of progress in science, it has not hesitated to publish articles which stimulate honest argument and which in so doing pave the way toward the approach to Truth. The Editor's door has been an open one, and will remain so.

The new editor of *The Digest* has been a science writer for many years and formerly was a member of the editorial staff of The Detroit News. He has been a member of numerous paleontological expeditions into the Rockies and has collected from New Mexico to Alaska, from Labrador to Puget Sound. He has done graduate work in geology at Columbia, the University of Michigan, and the University of California. He has taught university classes in geology. He is a member of the Society of Vertebrate Paleontology and a charter member and currently vice-president of the Michigan Mineralogical Society, one of the most active and progressive groups of its kind in the United States. The Digest for which he has frequently written, will continue to grow under his leadership.

To the multitude of friends we have made through *The Earth Science Digest*, to our contributors, to the advertisers who saw us through when the going was rough, to all these, best wishes.

ROBERT B. BERRY.

COVER PHOTO

From Maine to the Pacific, across mountain and plain, geologists swarmed over the rocks this summer. Field work was in full swing, in step with the nation's progress toward full recovery. A new generation of geologists, resuming studies interrupted by war, invaded the field while seasoned prospectors were back in the hills, seeking out Nature's hidden wealth. Epitomizing the summer's activities is the cover scene, taken by the Editor near Camp Davis, the Rocky Mountain field station of the University of Michigan, in Hoback Canyon, Wyoming, during the final reconnaissance trip of the season's field course. The cliff consists of the conglomerate of the Camp Davis (Miocene-Pliocene) formation.

A bulldozer is used to remove overburden on the site where the Nebraska marsupial "tiger" was found. This site became famous many years ago when the first-known American "shovel tusker" elephant was found here. Soon the waters of a new reservoir in the Republican River basin will cover a part of this locality.

A Marsupial "Tiger" Is Found In Nebraska

Invasion of Continent by South American "Kangaroo Cats" Revealed by Epochal Discovery in Ancient River Bed

By H. P. Zuidema

Editor, *The Earth Science Digest*

The sun beats down on southwestern Nebraska and the heat waves dance on the hillsides as paleontologists of the University of Nebraska State Museum dig into the slope of an abandoned gravel pit near the town of Cambridge.

This is the site of the discovery by university fossil hunters some 20 years ago of the first-known American "shovel tusk" elephant. The same area has yielded scattered bones of the giant bear-dog, tapirs, rhinoceroses and ground sloths. So the diggers work carefully and thoroughly, for the backwaters of a Republican River basin reservoir soon will cover a large part of the area and remove it from scientific scrutiny, possibly forever.

The leader of the group stares unbelievingly as a huge skull of a catlike animal is unearthed. The bony ring around the eye-socket, the orbit, is closed and not open posteriorly as in true "cats". Long, dagger-like tusks, the animal's deadly "stabbing teeth," lay broken, but restorable, with the skull. But this is not just another sabre-tooth "tiger".

Soon the telephone rings in the office of Dr. C. Bertrand Schultz, director of the museum and its field parties, in distant Lincoln, and by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nightfall the world learns that a marsupial sabre-tooth has been discovered in North America, first of its kind to be found on this continent.

Once again a field discovery sheds light on the migrations of extinct

First marsupial sabre-tooth tiger to be discovered in North America. Note closed eye socket.

mammals and another gap is filled in the broken story of ancient life.

"Marsupial" brings to mind Australia, and kangaroos. We think of nothing fearsome when we hear the term, but rather of pouch-bearing animals with cunning young, of opposums and wallabies. But here, long buried in the Pliocene gravels of Nebraska, appears a marsupial which was the terror of its day, mighty in muscle and bone and, while possibly not endowed with the mental quickness of his foes, well fitted to carry on the struggle for existence.

The marsupials are the pouched or non-placental mammals, which differ from other mammals in that the young are born so early in their development that they cannot swallow and must be transferred by the mother upon birth to a hair-lined abdominal pouch into which the nipples open. Milk is pumped by the mother to the young by intermittant muscular action until the young are sufficiently mature to leave the pouch. The sabre-tooth of Nebraska was a member of this group, as examination of the skull revealed.

The high-crowned teeth mimic in form those of the great true carnivores, but, as Dr. Schultz points out as he examines the amazing find, they are in structure quite kangaroo-like. Even in the absence of other bones of the skeleton, the marsupial brand is there. The brain case is smaller in relation to skull size, than in the higher mammals, and the closed orbit similarly is diagnostic.

The term "kangaroo cat" may offend the principles of classification, yet here is a marsupial whose type adopted the ways of the cat-like carnivores and at the end of the line of development through the ages bore

How the animal probably looked in life. A sketch by James Carmel, University of Nebraska artist.

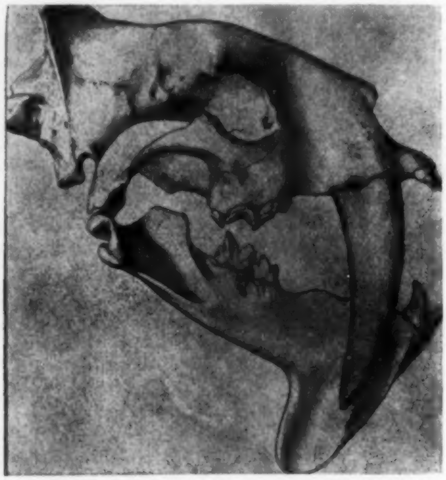
startling superficial resemblance to the true sabre-tooths.

Particularly astonishing are the large flanges developed on the lower jaws of both the marsupial "cat" and the true sabre-tooths, evidently use-

☚ Paleontologists of the University of Nebraska field party at work in gravels which contained the fossil marsupial sabre-tooth tiger.
University of Nebraska photo by Wendell Hoffman.

ful in protecting the protruding ends of the dagger-like canine teeth when the mouth was closed. It would appear that the teeth could be used only when the mouth was opened widely, and then as stabbing, instead of biting, weapons.

To students of organic evolution, the marsupials are interesting largely because of such amazing examples of "convergent" development as that shown by the Nebraska creature and the true stabbing cats of ancient times. When conditions permitted unhindered expansion of the marsupials, they adopted varying modes of life, as they did so dramatically in Australia due to the long geographic isolation of that continent.



A true sabre-tooth, a type marvelously "mimicked" by the marsupial "cat". This great carnivore, *Eusmilus sicarius*, the terror of his time, lived in the American west in the Oligocene epoch. Compare with marsupial "tiger" skull on page 7.

The wombat of "down under" is neither bat nor rodent, but a burrowing marsupial. The "Tasmanian wolf" is not a wolf, but a predaceous marsupial. The Australian native cats are not cats, and the "teddy bear" or koala, is not a bear, but a tree-dwelling non-placental.

In North America there are no living marsupials today, except the opposums, and South America, once replete with many marsupial types, now similarly has only the opposums and the rare, little *Caenolestes*.

South America, as Australia and its adjoining islands are today, was long isolated while the Panamanian land-bridge to North America lay beneath the sea. From the Eocene to the end of the Miocene geological epochs, the southern continent was a faunal "island" and the fossil record reflects a wondrous development of the marsupials. Finally, at the end of the Miocene, the isthmus between the continents rose and migration of mammals in both directions began.

However, as the late distinguished paleontologist, William Berryman Scott, pointed out, "the tropics between two warm temperate zones acted as a huge sieve, holding back most mammals and allowing but a relatively small number of climatically adaptable species to pass through."

The invasion from the north appears to have been the most successful and the higher mammals, immigrants from the north, as Dr. Schultz emphasizes, practically wiped out most of the ancient South American lines.

"But the sabre-tooth marsupial represents reversal of a trend," the Nebraska museum director points out. "This ferocious fellow made his way north, probably following his favorite prey, which may have been the giant ground sloth, which we have found in the same deposits in Nebraska. That he held his own against the large North American carnivores is evident. There must have been many of his kind in this country. I see no reason why sometime in the future other specimens of the same genus may not be found."

While the Nebraska marsupial "tiger" is the first of its kind to be found in North America, predaceous

(To Page 31)

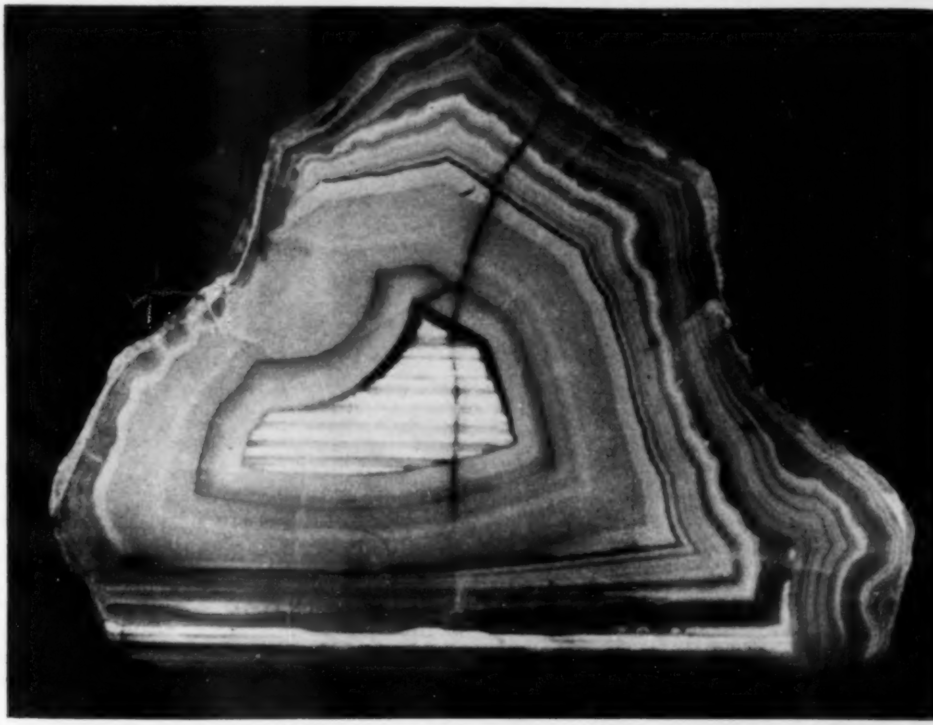


Fig. 10. **Blue-gray fortification-chalcedonyx combination with second generation of chalcedony in center and crowded eye-agate hemispheres in dark band.**

A Study of Lake Superior Agate

Interpretation of Structural Forms and Mode of Origin by Superficial Examination

THEODORE C. VANASSE

(Part I)

A study of available literature on Lake Superior agate indicates a need for further clarification of structural variations and associated nomenclature as related to its mode of origin. Such a clarification becomes increasingly pertinent because of the growing multitude of amateur lapidaries and information-seeking, science-minded collectors.

Since such lapidaries and collectors are rarely professional or experienced scientists, it would be well if a method were provided for interpreting agate structures by simple superficial examination of rough agates and of sawed and polished sections from them. Rarely does the average collector have access to physical and chemical laboratory methods. Almost as rarely does he have access to the technical reports of those scientists who do research with silica jel. Thus a suitable method of interpretation by superficial examination would immeasurably enhance the value of many a non-scientific collection both for its owner and for others. Furthermore a clearer understanding of the structure and origin of various agate types would ultimately tend toward the recognition of those "missing links" in the agate story that now lie in many collections as merely interesting rocks.

Fig. 1. **Fortification agate with flow structures and quartz crystal filling. Entrance duct to inner chambers is visible just beneath polished surface to right of upper center.**

The average collector is further hampered in any research work that he might do by the fact that existing literature on agate is at best incomplete and often regrettably at variance with the facts as observed in any large collection of agates. Conflicting theories on agate formation are offered him with little attempt at a final clarification other than that the silica jel theory and associated Liesegang phenomena are probably responsible for agates in toto, whereas the truth probably is that no single mode of formation can account for all agates, and no single theory can account for all structures seen in an individual agate. Confusion in nomenclature breeds further confusion in interpretation of structure. As an example of this, witness the incorrect interpretation and definition of eye-agate and the ill-founded attempt to change its name to ring-agate. (1)

For many reasons similar to the above then, this study is offered as an attempt to provide the basis for a method of superficial examination and interpretation of agate structures. It makes no pretense of completeness or finality. Rather it is offered simply as a beginning and with the hope that it will contain at least a few sign-posts pointing the way toward eventual, complete understanding of all silica jel products in nature.

It is based upon a study of about one thousand cut and polished Lake Superior agates. These agates, or representatives from them, were chosen for completeness of banding and variety of structural detail. Although many agates were included that could not be explained simply by the methods expounded here, no agates were seen that contradicted or voided these methods.

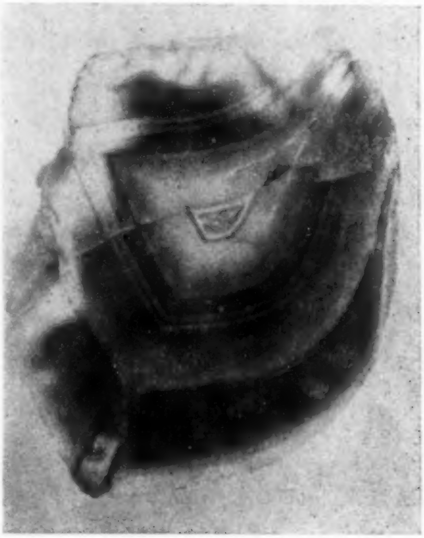


Fig. 2. **Small agate with clogged entrance duct at lower left.**

(1) WILSON, BEN HUR, "Ring-Agate" vs. "Eye-Agate." *The Mineralogist*, June, 1939.

This study is based, furthermore, upon the following assumptions or "notions":

Fig. 3. Entrance duct below for outer portion of agate. Foreign crystal cavity at left. Flow structure and band thinning around both lower and upper entrances.

1. The simplest explanation of natural phenomena is probably the correct explanation.

2. The key to most of the problems of agate formation is to be found (1) in the agates themselves. A superficial, leisurely examination of agates and their polished sections might thus reveal more of their secrets than hurried trips to lava flows and doubtful though beautiful experiments with gelatin in laboratories.

3. Perhaps, after all, previous investigations to the contrary, the agate structures are just what they appear to be, and are not something much more mysterious and complex.

And finally, this study is, in part, admittedly controversial. Where disagreement occurs, however, it is included, not maliciously, but simply in the usual spirit of many-faceted inquiry. If much of what follows appears as mere idle speculation, that too is freely granted in the hope that even speculation might rejuvenate a subject that has reached virtual stagnation.

Formation Theory

How did agates form? The question is one that every collector must answer almost daily. A more pertinent question when confronted with an individual agate would be: How did this particular agate form? In view of these oft-repeated questions, then, the briefest possible summary of current agate theory is in order.

First of all it is granted that all agates developed as a secondary deposit in cavities and open seams in rock. Such cavities were probably left in hardened lava flows by steam and gas bubbles. Other openings were caused by chemical solution of rock, by shrinkage during cooling, or by any earth disturbance that would alter the originally solid rocks.

At all depths between certain varying maximum and minimum limits the rocks of the earth are filled with water. Depending upon the nature of the surrounding rock, this water is either slightly acid or slightly alka-

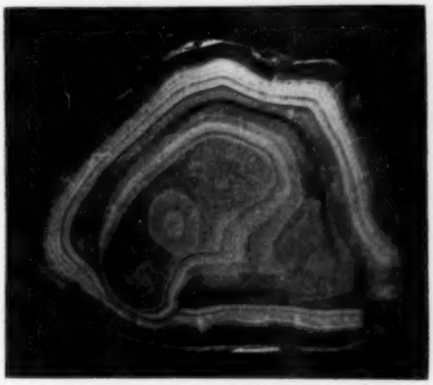


Fig. 4. Structural variations in fortification agate. Erosion and apparent sloughing below. Variable width of crystal bands above.

line and thus is enabled to dissolve a portion of all minerals with which it comes in contact. Thus even quartz (silicon dioxide) enters into solution. This solution, however, is colloidal in nature, and when highly saturated attains the consistency of a jel. This colloidal jel is probably not a simple

Fig. 5. **Eroded sardonyx layers with later quartz crystal filling. Note dissepimental layers and indistinct eye-agates.**

true solution but a mixture of actually dissolved silicon dioxide and finely-divided, suspended particles of silica. Although we shall bear in mind the dual nature of this solution, in parts of what follows we shall simply refer to the solution as a true solution containing free molecules. For a recent technical discussion of the nature and properties of this colloidal jel the reader is referred to reference (2).

Seepage and percolation of this solution through the rock obviously causes its accumulation in cavities. If further silica is dissolved, the solution becomes supersaturated and then, with the additional aid of variations in mineral content, and in temperature, pressure, and evaporation, excess molecules of silicon dioxide or particles of silica must pass out of the solution as crystalline or micro-crystalline quartz.

When a quartz crystal forms, molecules of silicon dioxide move out of the supersaturated solution and arrange themselves in rows and tiers having an hexagonal outline. Further additions of molecules always follow this order and the hexagonal form is maintained regardless of the size attained by the crystal.

Some chemists believe that quartz crystals cannot grow in a colloidal solution because of surface tension. So when molecules or excess suspended particles of silica are forced out of solution by supersaturation or other cause, they must form non-crystalline or amorphous quartz. This form is known as chalcedony, the major constituent of agate. Chalcedony bands in agate, however, are composed of microscopic fibers or crystals, indicating either that the suspended particles are true crystals or that molecules leaving the solution have still adhered as closely as conditions allow to their hexagonal pattern (3).

It is at this point that differences in opinion enter into agate theory. Behaviour of silica jel is not completely understood, especially under conditions found deep in the earth (2). Banding of agate has also had various interpretations, some scien-

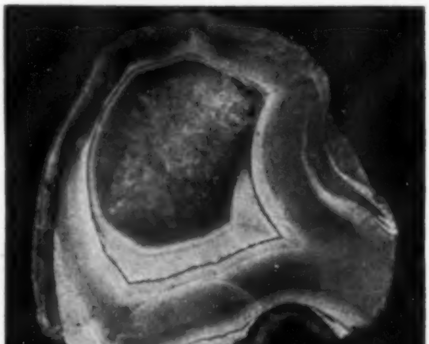


Fig. 6. **Fractional banding in a flow channel.**

(2) Copisarow, A. C., and Copisarow, M., Formation of Hyalite and Opal, *Science*, Vol. 104, No. 2700, Sept., 1946.

(3) Dake, Fleener, Wilson, *Quartz Family Minerals*, McGraw-Hill, 1939.

tists adhering to one theory, others to another.

Original investigators interpreted agate bands as a layer-by-layer deposit — as lime is deposited in a teakettle. Others thought that outer bands would seal out available solutions, and adopted a similar theory with the addition of entrance canals or ducts. Still others, and more recently, have assumed that cavities were filled with silica jel which simply hardened into agates. The banding, they say, resulted from a rhythmic deposition simulating the Liesegang phenomena, in which agate-like structures grow in jels in the laboratory. Quartz central fillings were interpreted as a later filling with crystals after the shrinking effect of desiccation had lessened surface tension.

This study, based solely upon a superficial examination of agate structures, denies the possible explanation of all agates by any single theory. Numerous agates show unmistakable evidence of multiple and varying modes of formation. Some quite obviously indicate layer-by-layer deposition. Most, after thorough dissection, show one or two, and often several, entrance ducts. Others show that the cavity, once filled with silica jel solution, stayed full until the agate was completed, but show little possibility that a static mass of jel hardened into an agate. In fact no agate used in this study offers anything more than a mere shred of evidence in support of the present concept of the filled-cavity silica jel theory. And finally, in few agates has anything been seen to support or obviously simulate the Liesegang phenomena.

The micro-crystalline or fibrous nature of agate bands is an argument against the Liesegang phenomena. The micro-crystals are arranged side by side in a direction normal to the plane of the banding. As

California Convention

The annual convention of the California Federation of Mineralogical Societies will be held at Long Beach, Calif., on July 16, 17 and 18, 1948, and not in June, as originally planned. The change was made in order to cooperate with the new National Federation of Mineralogical Societies. Information regarding the convention may be obtained from Lowell R. Gordon, convention chairman, 1850 E. Pacific Coast Highway, Long Beach 6, Calif.

layer was added to layer the crystals naturally interlocked, yet each layer or band remained a distinct and seprate part of the agate structure. This fact is shown in fracture and weathering phenomena, the bands often

Fig. 7. **Agate pipes in traprock. This enlargement fails to show circular banding at ends of pipes.**

separating as concentric shells. Such concentric shelling would indicate a lack of homogeneity not compatible with a simple, simultaneous hardening and rhythmic coloring process. Further the Liesegang phenomena fails completely to explain the coloring and horizontal form of sardonyx and chalcedonyx, in which layers often terminate abruptly against the sides of the cavity.

Rhythmic deposition cannot explain interpolated quartz crystal bands seen in many agates. Appearance of such bands implies a change in the chemical nature of the silica solution. Such a change, such a rhythmic change, would be very unlikely in a hardening mass of static silica jel. That changes did take place is well shown by the great variety of agate-enclosed quartz crystal structures. Occasional agates show a complete reversal of the usual sequence — a thick layer of quartz crystals is followed by an interior filling of fortification banding. The variations in number and position of quartz bands indicates that if rhythm were indeed present in the process of deposition, it was a rhythm in either the rise and fall of the water level or a rhythm in mineral variations caused by some unknown factor in the earth's chemistry.

Other arguments unfavorable to the hardening of a mass of silica jel and to the Liesegang phenomena are to be found in a consideration of the structure of eye-agates and in the structure of entrance ducts.

Eye-agates, as discussed in another section, are distinct and separate little agates. They bear the same relationship to the agate proper as a stalactite bears to a calcite-filled cave. The stalactite grows by layer-by-layer deposition of crystallizing calcite. In cases where a single drop of calcite-bearing water is simply fed for a time without growing downward, the hardened droplet has the

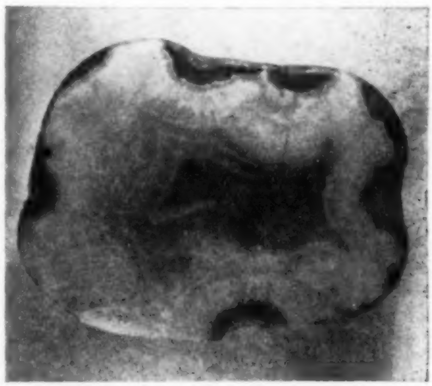


Fig. 8. **Radiating milky quartz crystals with red fortification banding toward center. Entire structure subsequently sealed with dense, glassy, transparent chalcedony.**

same appearance as the eye-agate structure. Were it not for this analogous formation, the Liesegang phenomena might seem to apply to observed eye-agates. However, layer-by-layer deposition is indicated. Indeed the whole agate theory is possibly shown by analogy in cave-filling processes.

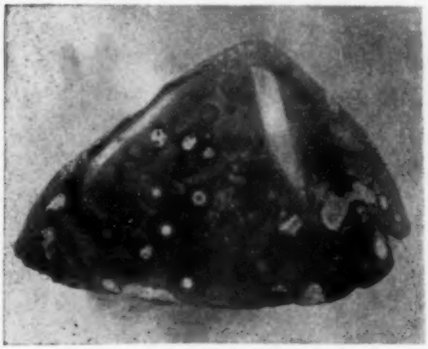


Fig. 9. Numerous varicolored eye-agates near surface of red jasper agate.

The same reasoning applies to all tubular, stalactitic, and canal or duct structures. Agate stalactites indicate growth during longer intervals of cavity "sweating." Tubular structures may be haphazard in direction and could indicate a meandering flow. Such tubes could also be formed by a process resembling laboratory experiments with water-glass and copper salts, in which dendritic tubes rise through water — one simulation of the Liesegang phenomena. Such structures in Lake Superior agates were probably caused by the presence within the cavity of an excess of an iron mineral, for agates have been found that merge with jasper. Others of the type have remnants of ore attached or enclosed.

Entrance canals are probably present in many agates thought not to possess them. They may often be detected only by a chance cut or fracture. For example, the agate shown in Fig. 1 has a distinct duct leading from the exterior to the interior section. It lies about one-fourth of an inch below the polished surface, which is fairly transparent, penetrates all the visible bands, yet affects their continuity and thickness only to the extent of a slight collar at each juncture.

The duct shown in Fig. 2 revealed its presence by a tiny red spot on the blue outer surface. A section through any other spot or in any other direction would have left this interesting canal undetected. The structure of this specimen indicates that flow aided in keeping the duct open until a foreign fragment wedged into its narrow opening and hastened sealing. The bands show that further deposition was accomplished by entrance through the opposite end alone.

Flow through entrance and exit canals often results in the most beautiful and intricate of agate structures. Deposition is thin near entrances to ducts and thick at a distance from them. Uniform bands often appear to slough away sharply as if by erosion. (Figs. 1-4). Erosion, in fact, did occur in some empty cavities containing a floor of the onyx variety of agate. Portions of the horizontal bands were completely removed and

Fig. 11. Incomplete color penetration into broken, weathered agate.

replaced by quartz crystals or other structures. (Fig. 5).

In cavities where flow and only partial intermittent filling with solution occurred, sardonyx could not be deposited. Instead, (Fig. 6), fractional, curved bands were formed, thin near the entrance, thicker away from it.

The point of entrance of distinct tubular canals into Lake Superior agates is often concealed by the finely checked and weathered exterior. Occasionally, however, circular banding resembling an eye-agate reveals its presence. Since circular-banded, agatized tubes are found in basalt, (Fig. 7), it is probable that some agates were originally conected to pipes and even interconnected by them before separation from the basalt matrix.

The prevalence of unsuspected entrance ducts of this type lessen the importance of the discussion on impervious agate layers. That prevalence in the agates studied, together with the difficulty of exposure, increases the probability that canals are present in all agates if they could be found by proper dissection. Concerning the perviousness of agates, however, it is possible that all newly-laid bands were relatively porous for a time. After the cavities were completely filled, the continued penetration of silica would successfully seal all inter-crystal pores (Fig. 8), and produce the well-known density and toughness. Thus, granting the plausibility of this speculation, even the few agates without entrance canals would eventually reach a complete form. Because of the dual nature of the silica solution — suspended particles and actually dissolved silicon dioxide — quartz crystal central fillings may have been caused by the absence of ducts or by closed ducts and by agate bands impervious to the suspended particles. Thus the quartz crystals may have grown from the filtered and actual solution of silicon dioxide.

The presence of eye-agates, entrance ducts, and flow structures thus has an obvious and important bearing upon agate theory. Indeed their presence demands a revision of major portions of present theory. Since in no possible way explainable by the filled-cavity silica jel theory could the ducts in Figs, 1, 2, 3 have been formed, the only alternative is revision to a theory in which duct formation is possible. Similarly for other agate structures. Revision, according to this study, means, not a denial of the presence of a colloidal solution, but abandonment of processes at present ascribed to that solution. Revision, indeed, may mean a return to a modified layer-by-layer deposition theory in which due consideration is given to multiple and variable structures, modes, and conditions.

Color

Lake Superior agates occur in a great diversity of color—red, brown, orange, yellow, gray, white, green, blue-green, and in combinations of these colors. They vary also in degree of jasperization, from dull, brick-red and completely opaque in sard to none at all in the clear and brilliant carnelians. White and bluish chalcedony also varies from translucence to porcelain-like opacity.

As in the agate proper, eye-agates show great diversity of color. One brick-red, highly jasperized agate used in this study contains blue-gray, pink, white, orange, red, and transparent eyes among the thirty-six such structures exposed on a scant two square inches of polished outer surface. As in this stone, partly shown in Fig. 9, the color of eyes shows little relationship to the color of the matrix agate. Such diversity is undoubtedly due to the fact that the eyes, buried under the relatively case-hardened and unbroken exterior, derived their coloring matter from a different source than did the agate itself (4).

Onyx varieties also show color combinations often unrelated to the surrounding agate matrix. Coloring material in these stones too probably came from a different source. Also the onyx layers may have been exposed to a greater or a lesser degree than the fortification bands above them. The more pervious ends of the onyx variety layers are often effectively sealed against the surrounding bands, and this condition would result in different or less color. Fig. 10 shows a bluish-gray agate in which the final generation of chalcedonyx is alternately translucent gray and opaque white. Another greenish agate contains brilliant yellow sardonyx layers. Other individual stones contain combinations of layers of red and white sardonyx, bluish chalcedonyx, and layers composed of either smoky or milky quartz.

Evidence afforded by many agates seems to indicate that all Lake Superior agates were of the colorless, translucent, South American variety at the time of formation. Instead of colored bands deposited rhythmically, the more porous bands took on color from the iron-filled gravels after the nodules were freed from their matrix. Broken stones acquired the greatest amount of coloring matter by capillarity between bands. Numerous stones show the coloring process in various stages of completion (Fig. 11), from which we may conclude that the coloring depends upon the availability of iron salts, the physical condition of the stone itself, and upon the chemistry of weathering.

(Editor's Note: Mr. Vanasse will conclude his discussion of Lake Superior agate in the September number of Earth Science Digest.

(4) Farrington, O. C., and Berthold, Laufer, *Agate*, Field Museum, Chicago, Geology Leaflet 8, 1927.

A CALL FOR AID

An European subscriber of The Earth Science Digest, Ignacy J. T. Krause, veteran mining engineer, is attempting to rebuild his laboratory and library, destroyed during the war, and asks readers of The Digest who may have catalogs and pamphlets on ore deposits which they can spare to send them to him. He is working on a book on mineral deposits in his own and other countries. The address of Mr. Krause is, ulica Ludwika Rzepecklego 45, Poznan, Poland.

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FAMOUS LOST MINES

— Fifth of a Series —

BY VICTOR SHAW

THE LOST ARCH DIGGINGS

Of the many lost mines in North America, and nearly every mining district has its quota, there are always some which are nothing but myths with no basis in fact. These gained credence for various reasons. Some were the inventions of crooks aimed at attracting the gullible public to invest cash, which rested safely

in the schemer's pocket when he left for other fields. And some were merely tall tales spun to fantastic lengths solely to intrigue some credulous audience. A few of this type have been exploded.

But the tales of the lost mines of the Southwest comprising this series for Earth Science Digest are quite different, for they've all been selected after much research of factual data for their seeming verity. Yet it should be noted that even these are usually more or less vague in details of position and direction, as is quite natural; for being handed down through the years such details are apt to become twisted, mixed or confused, and even lost entirely owing to the faulty memory of the original discoverer.

The Lost Arch is an example of the latter type.

Its general position, like that of the Lost Pegleg Smith, is thought to be authentic within an area of a few square miles, in one of the numerous canyons at the northern end of the Turtle Range, in the southeastern part of San Bernardino County, California. This Turtle Range has an over-all length of some twenty-five miles and runs in an almost due north and south direction. Its southern end extends nearly to the San Bernardino-Riverside county line, near the desert town of Rice, on the county highway from Desert Center to Parker Dam.

Its northern end lies about 20 airline miles east of the Old Woman Mountains, also about the same distance southwest of Needles, a division point on the Santa Fe R.R. and also on U.S. 66 not far from where that highway crosses the Colorado River. This northern end of the Turtle Range also is some 25 miles west of Parker Reservoir, where the Colorado River is backed up by the Parker Dam.

At this north end of the Turtles, in one of its many canyons, there is a natural bridge, or arch of rock, beneath which lie the gold-bearing gravels of a very rich placer concentration, practically upon surface and with little or no overburden of sand or earth. That is, it lay thus when first discovered, although in the succession of rainy seasons since then spring freshets may have covered it somewhat.

At any rate, it lies below the rocky arch mentioned and no doubt there is but one such natural bridge in this locality. The deposit has been twice discovered, and through the strange workings of fate was then twice lost; but, so far as is known, no one has found it for the third time so it may be there waiting. Find the arch, and you find the placer—unless an earthquake dislodged the arch. . . . Even so, the jumble of big rocks across the canyon floor easily might be identified, by some careful observer.

And today, there is a desert road that takes one right to this north end of the Turtles. Now the paved State Highway 195 runs south from Needles leaving U.S. 66 at a point 5½ miles from Needles; and passing just west of the Mohave Mountains, 195 leads south between the Turtles and the Whipple Mountains next to the Colorado River, and so on down to Blythe on U.S. 60-70. At a point about 16-17 miles south of Needles and on the west side of the Mohave Mountains, the desert road mentioned takes off from Highway 195 and strikes southwest for about 18 miles to the northern end of the Turtle Range. It is a dirt road and is passable for a jeep, and possibly also for a good car.

Needles, a division point on the Santa Fe R.R., is reached by U.S. 66 from Barstow but crosses the Colorado River at Topock. The Turtle Range is in plain sight from the Mohave Mountains on south, from both Highway 195 and the dirt road to the site of the Lost Arch. But State Highway 195 lies ten miles east of the Turtles when passing between them and the Whipple Mountains to the east. All present maps of San Bernardino County show these roads and mountains clearly.

The Mining World, in its issue of last December, it mentions that in early days a party of Mexicans were heading for the La Paz diggings, in the Dome Rock Mountains near Ehrenberg. When passing close to the north end of the Turtles, where they camped, they found an area covered by disintegrated oxidized hematite, which when panned yielded some $5.00 a pan in coarse gold. So, they stayed there to work this surface placer, as they had with them knock-down rockers. They put up two little adobe dwellings between which, as is their custom, an adobe arch was built to connect them by a sheltered open alleyway, of the type then called "San Juans".

This was in early spring and the arroyos all had quite a supply of water for washing out the gold; which was rich enough to yield them a total of some $30,000 in bullion, before the water dried up and stopped the work. They then left, intending to return next spring, but were said to have been unable to find that spot again, as the two mud shacks with the connecting arch had maybe fallen and been washed away.

However, assuming this tale is true, the site of that placer ground was only a mile or so from Coffin Springs, which is on the east side of the Turtles and at least six miles south of their northern end. There is much basalt through many of these desert hills, which rock very often carries large amounts of iron oxide. And, since this deposit apparently is placed so far from the supposed site of our Lost Arch placer, it seems likely that it is another deposit altogether. In any case, if the facts are as stated, it affords an additional incentive for any ambitious prospector to carefully explore this entire region.

Moreover, the late maps of this district showing waterholes and mines old or new, not only indicates five springs, or tanks, in this northern end of the Turtles, but also show an old mine not far from a canyon well called "Mohawk Springs" on the northwest side of the Turtles. This is marked by the symbol usually used to indicate a lode deposit, meaning an ore-bearing vein of quartz. All this is given to furnish additional data on this particular area.

Getting back to our story of the original discovery of the Lost Arch placer: It seems there was a prospector named Jim Fish, who had come West during the California gold rush, but in later years had been prospecting in various portions of Nevada. In 1883, Fish had acquired a partner named Crocker, and heading for California the two men had been working slowly south along the west side of Colorado River, stopping here and there to prospect nearby hills and pan the gravels of chance creeks. Their water supply was kept in a barrel lashed upon the rear of their old-fashioned buckboard with the camp outfit, which was drawn by a pair of bay horses of uncertain age.

When the events of this story occurred, they had filled their water barrel at the Colorado River near the Whipple Range, where the river is forced in a great bulge into Arizona to round the east extension of those mountains, and were then two day's travel from the river, a distance of some forty miles. They lived on game and they also traded with friendly Indians for dried corn and beans.

So, in late afternoon of this day they prepared to make camp not far from a range of desert hills; which were the northern end of the Turtle Range, although they were wholly unaware of the fact. The man, Crocker, set out for the hills on the chance of getting a deer, or perhaps some rabbits, while Fish stayed in camp to get supper. In dong this, he started to get water from their barrel and found that it was almost empty. Rolling it out to expose the bung, he pried it out to discover that there was less than enough water to fill two canteens.

This, as all desert travellers know, was an extremely serious matter, one which very easily could result in tragedy. While thus engaged Crocker returned empty-handed, and when told of the leaky barrel joined Fish in a conference to discuss their predicament and to decide about their next move. Crocker mentioned that he had seen quite a lot of vegetation in the canyons of the hills he had just hunted, which might mean the presence of water; so they decided to investigate at once, instead of trying for the river with not enough water to take them there.

"It's our best chance," Fish said. "In fact, our only one."

So after a scanty meal and few hours rest, they started at daybreak for the hills rising a mile or two south across the desert; both hoping desperately, as they plodded over the desert sand, to at least find water enough to fill the two canteens they carried. And the following account is essentially what happened, as Fish many months later told it to friends of his in San Bernardino.

"We hiked over to those hills," he said "that were less than two miles to the south of our camp, where we'd left the cayuses tied by hackamores to the buckboard. In the first big canyon we came to, there was a lot of chaparral and a few young cottonwoods and plenty of wild grass that was all burned dry; but there might be some pools left yet among the rocks, so we hiked along into it.

"There were some side canyons coming in right and left, and Crocker took one to the left, and I started up one that led into the higher hills on the righthand side and looked fairly promising. But, after a while things didn't look so good in my main canyon, so at a fork in the canyon I went up the righthand branch for quite a ways. But the sun was getting high now and with no air stirring in there, the heat from the side walls was getting almost unbearable.

"It was awful rough underfoot too, climbing over or around the big chunks fallen from the cliffs, and the cobbles and boulders everywhere on the bottom sure made it tough going. Lots of the boulders had mighty smooth surfaces that looked like they were polished by freshets in the spring rains; so I kept going in hope of finding water pools in among the rock piles, though I got scratched by catclaw and cactus and turned an ankle several times, jumping from one rock to another.

"Then suddenly when rounding a bend in the canyon, I saw an almighty big arch of rock that spanned clear across the canyon from one side wall to the other. Never seen anything like it before, and when I got right under it, where there was a big open space covered with sand, it was so shady that I laid right down on the sand to get my wind and cool off. And while I rested, I just looked up at that great arch and was scratching idly in the sand, when I noticed it felt strangely heavy. So I got on my knees and pawed away a lot of sand, and—sure enough as I suspected—there was gold under it. Plenty of it. Fact is it was just about all gold, as big as wheat or barley grains. Just a little sand on top, and I sure got excited. I'd looked so long for just that!

"Anyhow, it made me forget I was hunting for water so I began filling all my pockets with that heavy yellow stuff, till I had to hold up my levis with both hands, when I set out on the back trail to find Crocker and tell him the big news. But, I never saw him, as I stumbled along down into the main canyon and then off through the sagebrush clumps across the desert into camp."

When Fish reached their temporary camp and had quieted their restless thirsty team, he had to wait several hours before Crocker appeared, utterly fagged and very apprehensive, for he also had failed to find the slightest seep or trickle of the life-giving moisture. He was so worried, Fish said afterward, that he paid no attention to the gold his partner showed him. And, rightly, for should their failure to find water prove fatal, knowledge of the rich placer had no meaning. Our maps show five springs in those hills, yet they often go dry.

At any rate, having failed to locate the water so sorely needed, Fish and Crocker were forced to take their sole alternative: that arduous journey back to the Colorado River, toiling forty miles through the furnace heat of the desert, weak, weary, and with so little water. To us it seems strange that Fish, with his Nevada desert experience, did not insist that they travel only at night, when the desert chill renders thirst less pressing. However, Crocker may already have been getting unmanagable and this, with a team fast becoming unruly, quite likely caused Fish to start at once and against his judgment.

But during what proved a terrible journey, he did dole out the scanty supply of warm water by the spoonful for themselves alone. They gave the horses none, but merely wiped out their mouths with a dampened rag from time to time. At first Fish and Crocker walked to save the horses as much as possible, but later Crocker had to ride.

That first day of travel in the blasting heat soaked the flannel shirts and levis with a drenching sweat, which proved a temporary help through rapid evaporation. But, later in the day, they both became rather thoroughly de-hydrated and the consequent loss of salt so weakened Crocker that Fish put him on the buckboard to drive the team.

When at long last night fell, Fish's damp socks had raised great blisters on both heels, that at once broke and for hours he had limped along with boot heels rasping the raw bleeding flesh. The water was now almost gone, but they kept slogging ahead through the night always painfully heading due east toward the river, until finally the weak stumbling horses stalled and refused to go farther. So, almost completely exhausted themselves, they rested a while; until, when day-light brightened the east, they forced themselves to resume the terrible trek, on ever on toward the rising red ball of sun, where the Colorado's cool refreshing flood flowed swiftly southward.

But the second day proved far worse, for Fish stumbled and reeled along over the endless dunes, unable to dodge the catclaw and cactus; and Crocker collapsed on the buckboard seat, so Fish let their team take its own course guided solely by instinct. Then, late that afternoon, with Crocker in collapse and Fish himself almost at the end of his physical resources, he saw far ahead the welcome fresh green of the willows that fringed the river bank.

The sight perked him up at once, yet he could not force his benumbed legs more than to slog through the clogging sand as before, although he kept staring at that fringing green fearing it was a mirage. But the horses scented water and getting new strength from somewhere they tossed their heads, snorted, and plowed eagerly ahead. But their pace was slow, and Fish managed somehow to keep up with them. Later he described their arrival at the river somewhat as follows:

"Poor Crocker was then dead to the world, and when that crazy team bounced the buckboard over a hump, I nearly lost him a time or so. And when we got to the river bank, the blasted team wasn't going to stop, but I got hold of the reins somehow and unhitched the traces and then they hit the water, traces and reins flapping.

"I drug Crocker down to the river and soused into it, him and me both.

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I knew better than to drink too much at first, but I washed out his mouth and took a sip myself, just letting that blessed stuff soak slowly into our hides for a while. Believe me, but it sure did feel like heaven on earth. We soon drank a little, and I got to feel more like myself but still mighty weak, and I saw then that the water had come too late for Crocker to make any come-back. Finally, I hitched up the team and drove him upriver to Ehrenberg, where I knew there was a doctor, but he couldn't do much and Crocker died a week later."

As a matter of fact, several weeks elapsed before Fish could recover from that experience, and three months passed before he felt he could safely start out again to return to his rich placer discovery. Oddly enough, his impression was that it lay at the north end of Old Woman Mountains, and his mistake can only be explained by the fact that this range and the Turtles are very similar in general appearance.

But, at the time Fish was sure he was right, and being persistent and very stubborn, he kept at it for so many expeditions that his reserve funds finally gave out. This forced him to quit and hunt a job, for he knew if he could locate that placer deposit, he would be able to live at ease the rest of his life. He told this to anyone who would listen, although his subsequent moves are not a matter of record.

However, for the next seventeen years, the rich placer remained undisturbed under its high rocky archway, so far as anyone knows; for it was not until 1900, that another prospector accidentally located that natural bridge in its proper canyon at the northern end of the Turtle Range, not knowing anything about the placer gravels under it.

This prospector was a German named Peter Kohler. At the time he saw the arch above its proper canyon, he was returning from a trip farther south during which he had found and staked several valuable ore veins, and was then returning by way of the Turtles. As he neared their northern end and had topped a high ridge-comb, he worked down the north slope to a little upland basin that was in full view of an odd arching bridge of rock spanning a deep canyon below.

In Germany, he had been a trained geologist, so the interesting natural bridge made a strong impression as he carefully examined it. He did not descend into that canyon, but selected more easy slopes into another large canyon leading into the desert, where he continued on his way toward Needles. There he was hoping to be able to find another prospector, who might be induced to join him as a partner and who was financially able to help him develop his claims. Before he reached Needles, however, he fell in with a prospector named, John Packer.

On their first evening together Kohler told Packer about his mining claims and that he needed development funds, and incidentally he also mentioned finding the odd natural bridge at the north end of the Turtle Range, while coming north to Needles. Packer saw that Kohler as yet had heard nothing of the rich placer Jim Fish had found under that arch, so he pretended disinterest and said nothing to Kohler about it.

Instead, Packer agreed to furnish an outfit to last several months, and that he would join Kohler in twenty days at a place on the east side of Old Woman Range called "Sunflower Springs". Kohler being in need of ready cash applied to the Santa Fe R.R. for work, and was ordered to Amboy to help unload lumber and mine timbers that had been side-tracked there for local delivery. Unfortunately, on the third day at this work, some heavy timbers toppled over and killed him.

On the day set to meet him, Packer went with the new outfit to Sunflower Springs and waited several days; but when Kohler failed to appear, Packer went back to Needles where he learned of Kohler's fatal accident. Then, since he now knew the location of the Lost Arch and was confident of finding the placer deposit under it, he at once packed his new outfit south heading for the Turtle Range. But, the canyon with its high rocky arch proved elusive, and though he searched ten years for it all his efforts were in vain, so he gave it up as hopeless.

Nevertheless, since its position is fairly well established, it still seems like a worthwhile venture to try again for it. By picking a suitable campsite close to that area, with an ample outfit plus a good water supply, a thorough search overlooking nothing, might bring good results, in either the possibly buried placer gravels, or maybe the quartz lode that furnished that gold. Or, even the Mexican placer six miles or so south near Coffin Springs, on the east side of the range.

WATCH FOR IT!

Do not miss the September issue of The Earth Science Digest. Articles will include:

"The Atmosphere", a revealing summary by Prof. W. D. Keller of the University of Missouri of what is known about the blanket of air which envelops our globe and how it acts as a geologic agent.

Another of the fascinating series of "Famous Lost Mines", by the veteran mining engineer and world-traveler, Victor Shaw. Next, "The Lost Breyfogle".

T. C. Vanasse will resume his discussion of Lake Superior agates.

And other articles you cannot obtain elsewhere. Do not miss the September issue. Extra copies may be ordered now.

Letters to the Editor

The Editor,
Earth Science Digest.
Dear Sir:

I am glad that your circulation is growing to the extent that it is and feel sure that it will continue to do so and you have a very nice magazine and the articles are exceptionally fine.

Sincerely,
Mrs. John B. Clarke,
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Frank Lyman,
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BOOKS and MAGAZINES

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(From Page 8)

marsupials have been found in the fossil beds of South America and one of them, a huge sabre-tooth, was discovered some years ago by Dr. E. S. Riggs of the Chicago Natural History Museum in the foothills of the Andes in northwestern Argentina. He named this remarkable animal *Thylacosmilus atrox.* The age of the beds in which this animal was found is Pliocene, and the discovery remained unique until this summer's find by the Nebraska field party. The Nebraskan marsupial "tiger", however, represents an advanced stage of development over the South American type.

The Marsupial "Tiger" in Time

Cenozoic Era	Recent Epoch	Dominance of Man
	Pleistocene	Periodic Glaciations. Extinctions of large mammals. Began approx. a million years ago.
	Pliocene	Beginning of Man. ★Age of the Nebraska marsupial sabre-tooth.
	Miocene	Culmination of mammals.
	Oligocene	Culmination and extinction of archaic mammals.
	Eocene	Rise of mammals and modern floras.
Mesozoic Era	Dominance of reptiles (Ended approx. 60 million years ago).	

The horizon of the new specimen is the Sidney gravel of the upper Pliocene. Part of one of the great incisors, or stabbing teeth, of the animal was found 30 feet into the bank from where the skull rested and other bones which may be part of the same animal were found during further exploration.

A serious flood in the Cambridge area indirectly brought about the discovery. A. Allen Graffham, leader of the Nebraska field party, a former editor of The Earth Science Digest, was prevented from reaching other promising localities by washouts and damaged bridges and concentrated his efforts for a time at the site where the most important find of the summer was made.

Did the Nebraska marsupial "tiger" ultimately meet his match in one of the true "sabre tooth" tigers of his time? The answer may be found as exploration of the site progresses. But after death the great pouched cat was swept into a stream channel and the bones scattered, so the complete story of his demise may never be told. Then followed deep burial in river deposits and, finally, erosion of the area, leading a few weeks ago to one of the most dramatic discoveries in North American paleontology.

Midwest Groups Join American Federation

Collectors of the west have been brought into association with hundreds of mid-western mineral collectors through the ratification of the constitution of the American Federation of Mineralogical Societies by the Midwest Federation of Geological Societies.

The action was taken at the convention of the Midwest groups, held in Detroit with the Michigan Mineralogical Society as host.

New president of the Midwest Federation is George C. Anderson, of the Chicago Rocks and Minerals Society. The vice-president is Ben Bagrowski, Wisconsin Geological Society; secretary, Loretta Koppen, Minnesota Geological Society, and treasurer, E. Lillian Mihelcic, of the Michigan society.

The invitation of the Chicago Rocks and Mineral Society to the Midwest Federation to meet in Chicago next year was accepted. Delegates to the American Federation convention are Ben Hur Wilson, of the Joliet Mineralogists, and Alger Syme, of the Minnesota society.

The Cranbrook Institute of Science, Bloomfield Hills, was the scene of the convention sessions and delegates inspected the notable mineral exhibit of that instiution. Visitors were greeted by Leslie R. Bacon, president of the Michigan society, and by Anne Proctor, secretary. Each registrant received a slab of Jasper conglomerate from Frank J. Campbell, of Waterford, Mich.

High spots of the program were field trips to Clay Center, O.; to the mineral display of C. O. Gettings, at Toledo; to Henry Ford's Greenfield Village, at Dearborn, and to the ceramic plant of the Champion Spark Plug Co. In Detroit, visits were made to private collections, including the superb collection of A. N. Goddard.

Principal speakers and their topics were: George V. Cohee, of the United States Geological Survey, "The Search for Oil in Michigan"; Helen Martin, Michigan Geological Survey Division, "Relations of Michigan Geology to the United States"; Willard Parsons, "Mineralogy in Michigan"; Mr. Goddard, "Mineral Collecting", and Ben Hur Wilson, "Review of the Growth of Mineral Societies".